Performance of an Attenuator Type Wave Energy Converter in Multi-directional Waves

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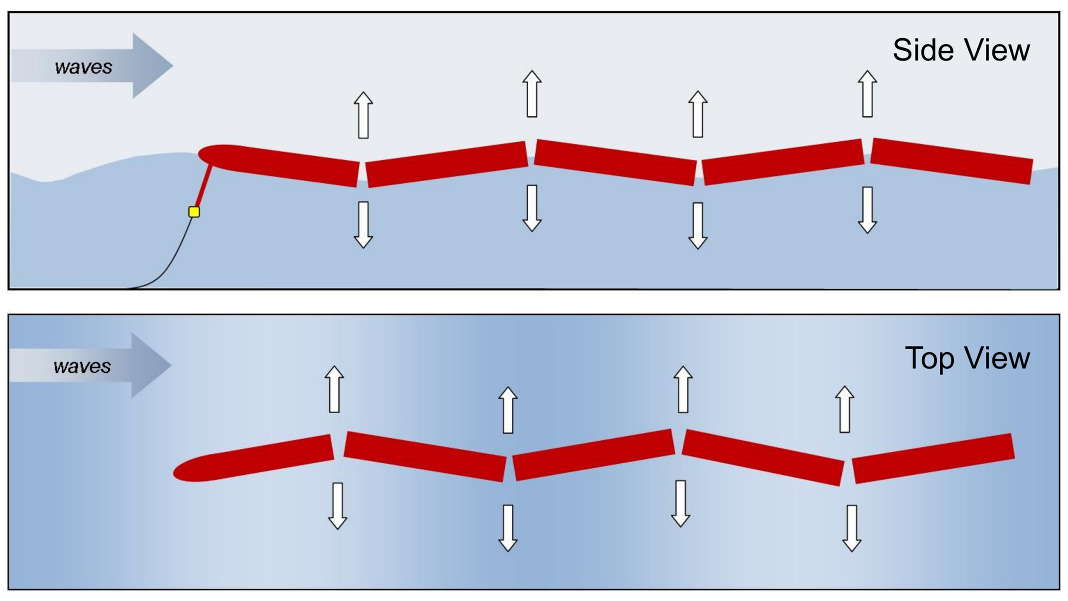
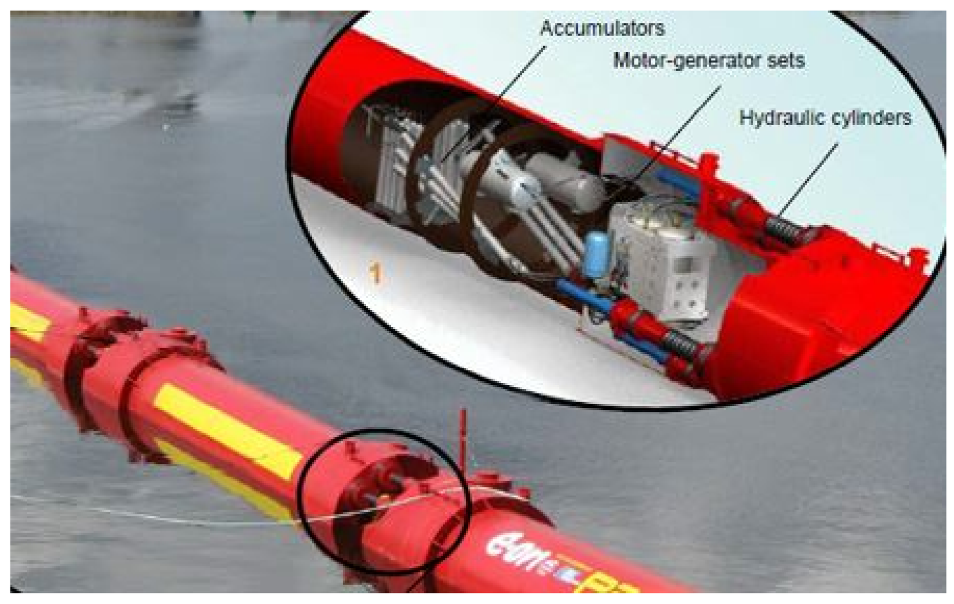
Background

The Pelamis is an attenuator type wave energy converter (WEC), which can capture energy from the relative pitch and yaw motions of the modules as the waves pass them. A second-order potential flow solver, DIFFRACT*, has been applied to investigate the performance of the simplified Pelamis in multi-directional waves.





Waves and Simplified WEC

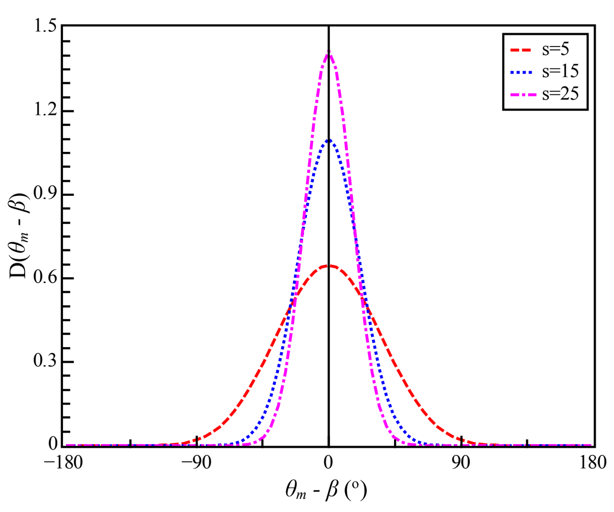
The basic idea in present research is to superpose all the wave components from different directions but with the same frequency as a single incoming wave. Different wave spreadings have been considered.

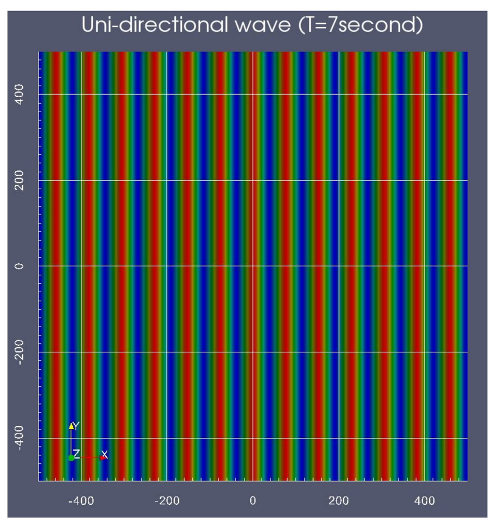
Linear incident waves:

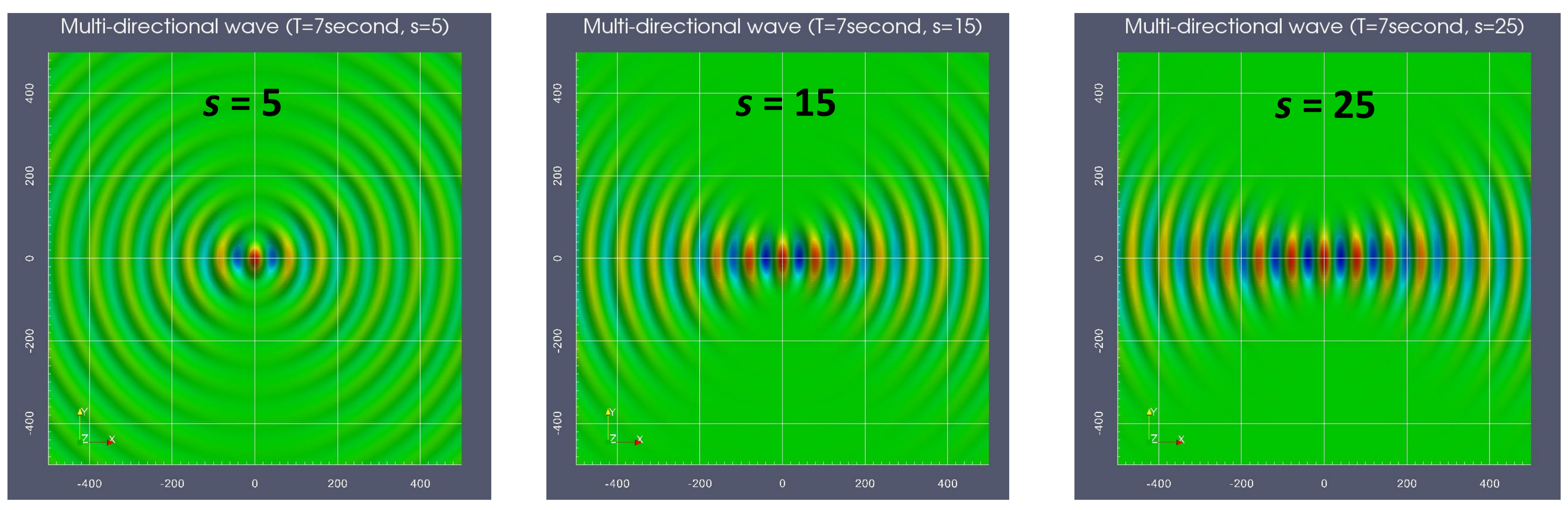
$$\phi_i = \sum_{m=1}^{M} \phi_{im} e^{ik(x\cos\theta_m + y\sin\theta_m)}$$

$$\phi_{im} = \frac{-i\omega A D(\theta_m - \beta)\Delta\theta}{k} \frac{\cosh k(z+d)}{\sinh kd}$$

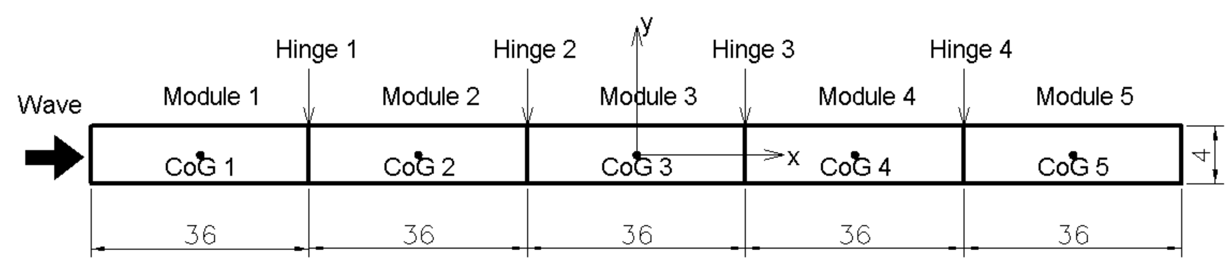
$$D(\theta_m - \beta) = \frac{\Gamma(s+1)}{2\sqrt{\pi}\,\Gamma(s+\frac{1}{2})} \cos^{2s}\left(\frac{\theta_m - \beta}{2}\right)$$



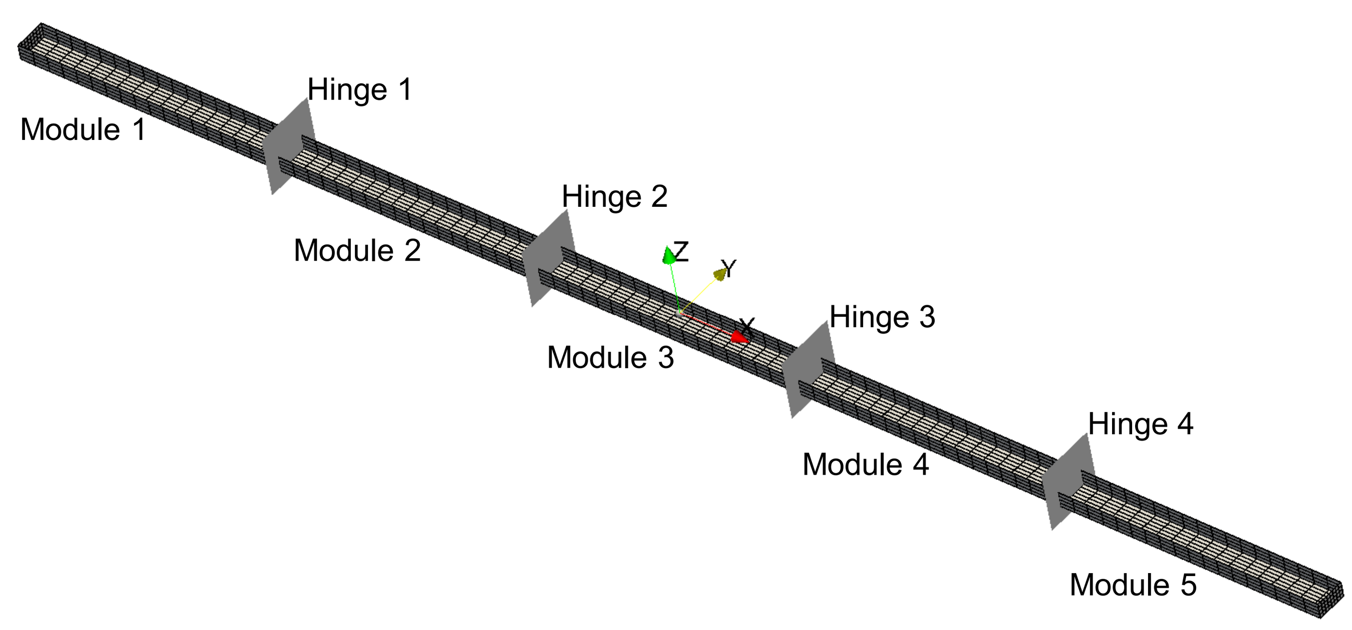




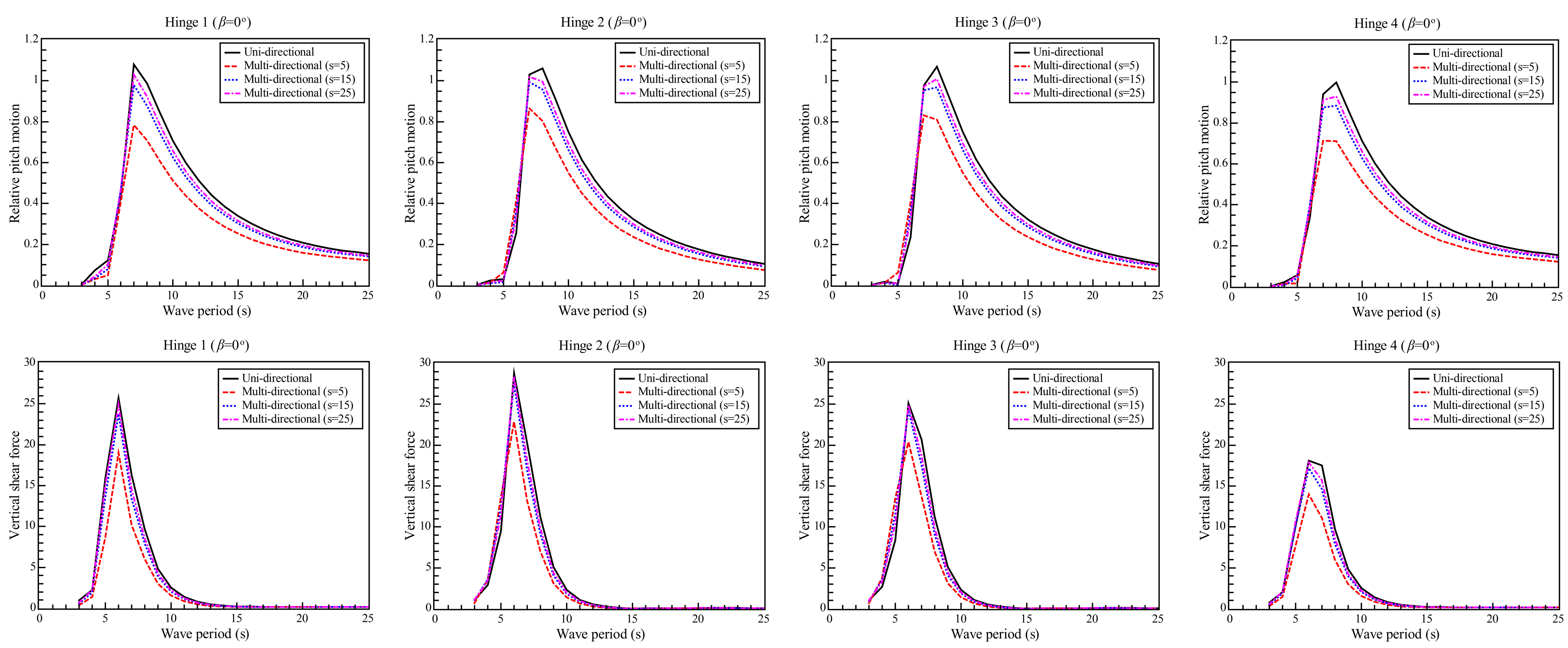
The wave energy converter has been simplified as 5 rigid rectangular boxes (draft=2m) connected by 4 ideal hinge joints (without damping and friction) which only allow the relative pitch and yaw motions between rigid modules.



Plan view of simplified wave energy converter (unit: m)



Numerical Results



In multi-directional seas, smaller relative pitch motions are obtained. Especially for *s*=5, the reductions of relative pitch motions at peak values are up to 27%. With the increase of spreading factor *s*, the relative pitch motions approach those in uni-directional waves.

It seems that there are no significant differences in vertical shear forces for uni-directional waves and multi-directional waves when *s*=15 and 25. However for multi-directional waves when *s*=5, peak shear forces have been reduced by up to 26%. Largest vertical shear forces are found at hinge 2.

Concluding Remarks

- Numerical results have shown that compared with the results for uni-directional waves, up to 27% of reductions of relative pitch motions of the converter and up to 26% of vertical shear forces acting on the simplified PTO (Power Take-Off) have been obtained when wave spreading factor *s*=5.
- The research has suggested that the design of wave energy converters needs to be optimised for different locations with different wave conditions.

* http://www.mendeley.com/groups/2020743/4diffract/papers/